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Applicant MYERS, Steve et al	

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(71) Applicants and

(72) Inventors: **MYERS, Steve [US/US]; 171 Vista Verde Way, Portola Valley, CA 94028 (US). STRASSER, Michael [US/US]; 3312 Los Huertas Road, Lafayette, CA 94549 (US).**

(74) Agents: **SMITH, Gregory, Scott et al.; 3900 Newpark Mall Road, Suite 317, Newark, CA 94560 (US).**

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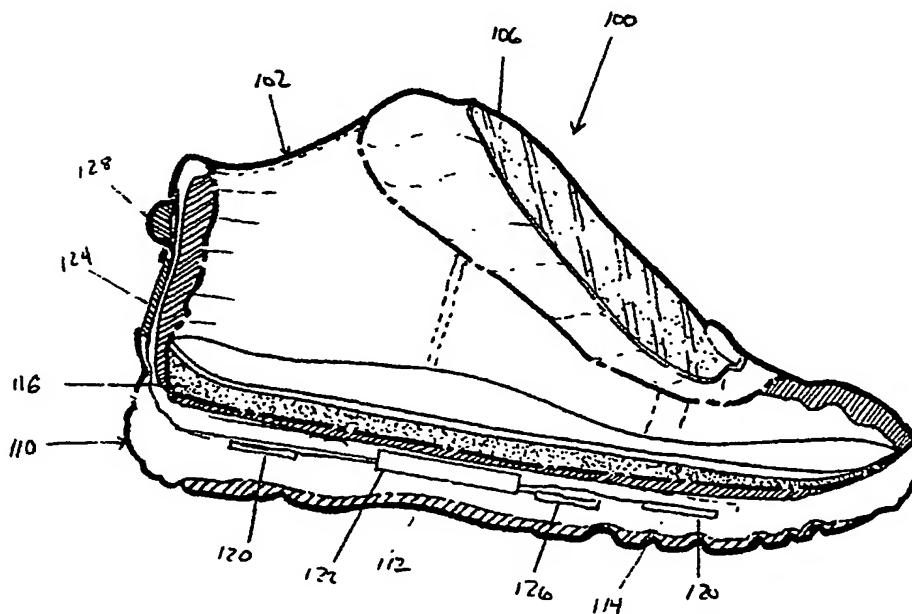
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(54) Title: **SHOE WEAR INDICATOR**



(57) Abstract: The present invention relates to a shoe (100) capable of indicating the approximate remaining useful life of the shock absorbing capability of the shoe (100). One preferred embodiment includes at least one sensor (120), operational circuitry (122) to manipulate the data received from the sensor (120), a display (124) for displaying a signal from the operational circuitry (122) either in audible or visual form relating to the remaining estimated life of the shoe (100), a power source (126) to provide the necessary electric power, and a switch or button (128) for activating the display (124).

Shoe Wear Indicator

5 TECHNICAL FIELD

The present invention relates to shoes capable of indicating the approximate remaining useful life of the shoes, and more specifically, to shoes capable of recording data relating to impacts experienced by the shoe, using the collected data to estimate
10 the remaining useful life of the shoe, and displaying the results in a manner visible or audible to the user.

BACKGROUND ART

15 Shoes are generally considered to be an essential item of apparel by most people for reducing the likelihood of injury, particularly when engaging in activities such as sports and running.

A typical generic athletic or active wear shoe includes a relatively soft and
20 flexible upper portion for surrounding at least part of the wearers foot, including a pair of side flaps which define a foot recess, a shoe tongue extending between the side flaps, and a means for securing the shoe side flaps to each other. Such shoes typically further include a sole to provide protection from and cushion against uncomfortable contact with a supporting surface such as the ground. The sole will typically further
25 comprise a series of layers of differing materials with differing characteristics, such as

a tough outsole component, a cushioned midsole component, and a soft insole component. The sole is typically affixed on its upper surface to the lower margin of the upper portion of the shoe by the use of an adhesive.

5 The midsole of conventional shoe construction functions as a shock absorber to cushion impacts experienced by the user's foot, and will deform in response to force exerted against it. The compression and decompression characteristics of the midsole layer are important both for protecting the user, and for the longevity of the shoe. The shock absorbing capability of the midsole of conventional shoes tends to
10 progressively deteriorate with use. Consumers of shoes, particularly athletic shoes and running shoes, are concerned with knowing when a shoe needs to be replaced. Wear on the outsole can be easily checked with an occasional visual inspection of the sole of the shoe. However, it is often difficult to tell when a shoe has lost its ability to provide sufficient cushioning or shock-absorbing effects.

15

Failure to replace shoes when the shock-absorbing abilities of the shoe have deteriorated may result in severe or disabling injuries. On the other hand, athletic shoes are generally perceived to be very expensive and premature retirement of shoes by as little as 5% to 10% of the anticipated life of the shoes may result in the
20 perception of a significant unwarranted expense or cost to the consumer.

Prior efforts have been made to develop a shoe that would indicate when the shock-absorbing ability of the shoe has deteriorated, and that the shoe must be

replaced. However, these prior attempts have not generally resulted in an acceptable shoe design.

What is needed is a shoe that can be simply and inexpensively constructed,
5 that is capable of estimating the loss of ability of the shoe to absorb impact, and that can visually or audibly indicate when the shoe should be replaced.

SUMMARY OF THE INVENTION

10 Accordingly, the present invention is a shoe that employs one or more force sensors to provide data relating to impacts experienced by the shoe, that uses the collected data to estimate the remaining useful life of the shoe, and displays the results in a form understandable by the user of the shoe. As used herein, the word "display" means the capability to convey information in any form including but not limited to
15 tactile, visual, and audible forms.

More specifically, the present invention comprises a shoe including at least one sensor responsive to impacts experienced by the shoe, operational circuitry in communication with the sensor, the operational circuitry capable of manipulating data
20 received from the sensor to estimate a remaining life of the shock absorbing capabilities of the shoe, a power source electrically coupled to the operational circuitry, and a display apparatus in communication with the operational circuitry. The sensor preferably sends a signal through the resistor network to the operational circuitry, and a strength of the signal varies depending on a force of an impact

experienced by the sensor. In other embodiments the shoe comprises at least two sensors. In such embodiments, it is preferable that at least one sensor be positioned in the sole of the shoe proximate the heel, and another in the sole of the shoe proximate the ball of the foot.

5

In some preferred embodiments the shoe further comprises a button or switch to activate the display. In a further preferred embodiment, the shoe further includes a resistor network between the sensor and the operational circuitry. In some embodiments, the operational circuitry may comprise a microprocessor. The resistor
10 network preferably converts the signal to a useable voltage and converts the signal to a form able to be used by digital electronics, and the resistor network preferably sends signals to the operational circuitry which allow the detection and differentiation of signals of varying signal strength received from the sensors.

15 The sensors may comprise a piezoelectric element, and may further comprise a rigid element positioned in contact with, or near the piezoelectric element to enhance the deformation of the piezoelectric element. The rigid element preferably extends transversely across the upper surface of the piezoelectric element, although in alternate embodiments the rigid element may be positioned effectively in other
20 locations.

The display may be visual or audible or both, and in alphanumeric or graphical format. The display used may include light emitting diodes, electroluminescent

panels, liquid crystal displays, flexible liquid crystal displays, or any other kinds of displays adaptable for use in the invention.

The invention further comprises a method for estimating the approximate
5 useful remaining life of the shock absorbing capability of the shoe, wherein the shoe
comprises at least one sensor, operational circuitry in communication with the sensor,
wherein the operational circuitry is capable of manipulating data received from the
sensor to estimate a remaining life of the shock absorbing capabilities of the shoe, a
power source electrically coupled to the operational circuitry, and a display in
10 communication with the operational circuitry capable of displaying information
related to the remaining useful life of the shock absorbing capabilities of the shoe; the
method comprising the following steps: (a) providing a pre-determined numerical
value; (b) receiving a signal; (c) applying an algorithm to derive a value; (d) adding
the numerical value of step (c) to a sum of such values to create a new value; (e)
15 comparing the new value of step (d) to the pre-determined value of step (a); (f)
estimating the remaining life of the shock absorbing ability of the shoe based on the
results of the comparison in step (e).

The method of the invention may also comprise the step of (g) displaying the
20 remaining life of the shock absorbing capability of the shoe based on the results of the
comparison in step (e). In another embodiment, the signal from the sensor may be
conditioned before step (b). Also, the method of the invention may be performed
separately for separate sensors.

BRIEF DESCRIPTION OF THE DRAWINGS

5 FIG. 1 shows a cutaway side view of an athletic shoe according to the invention.

FIG. 2 shows a block diagram of an embodiment of circuitry of the invention.

10

FIG. 3a shows a cutaway side view of the sole of a typical athletic shoe with an embodiment of the impact sensor in a neutral position.

15

FIG. 3b shows a cutaway side view of the sole of a typical athletic shoe with an embodiment of the impact sensor while being deflected.

FIG. 4 shows a schematic of an embodiment of the impact detection circuitry of the invention.

20

FIG. 5 shows a perspective view of the upper of the heel of an embodiment of the invention.

FIG. 6 shows a perspective view of an alternate embodiment of the upper of the heel of an embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

5 The present invention is a shoe including one or more impact sensors to provide data relating to impacts experienced by the shoe. The shoe further includes apparatus for collecting, storing, and analyzing the data in order to estimate the remaining useful life of the shoe, and that displays or conveys the results in a form comprehensible by the user of the shoe.

10

 The invention will be described by reference to the Figures 1 through 7, wherein like numbers refer to similar features. Although the Figures and the following detailed description show and discuss the invention in use on a typical athletic shoe, it is understood that the invention could be incorporated into any kind of footwear, including but not limited to dress shoes, boots, sandals, slippers, overshoes, and the like. Furthermore, the particular configuration of the shoe, and the method of making the shoe, are not critical to the invention, and any known and acceptable methods or means for manufacturing the shoe may be used.

20

 FIG. 1 shows a cutaway side view of a conventional generic athletic shoe 100 constructed in accordance with a preferred embodiment of the invention. The conventional athletic shoe 100 includes a relatively soft and flexible upper portion 102 for surrounding at least part of the wearers foot, including a pair of side flaps which define a foot recess, a tongue 106 extending between the side flaps, and a means for

securing the shoe side flaps to each other. Typically, laces are threaded through a plurality of lace eyelets disposed along parallel opposing sides of the flaps to secure the shoe 100, however, other fastening means such as known hook and loop fastener straps or elastic materials may be used. The shoe 100 further includes a sole 110 to
5 provide protection from and cushion against uncomfortable contact with a supporting surface such as the ground. Typical materials used in the upper portion 102 of the shoe 100 include leather and man made sheet materials such as polyvinyl or polyurethane sheets, or a combination thereof. The particular materials used in the upper portion 102 of the shoe 100 are not critical to the invention. These materials
10 may be die-cut or laser-cut and stitched over a foot shaped last to form the finished upper portion 102. The sole 110 is typically molded or formed from one or more elastomeric materials such as foamed or solid polyurethane or ethylene vinyl acetate, and are configured to include common structural features such as a top or footbed surface, a peripheral outer or side wall surface, and a bottom or ground contacting
15 surface. The particular configuration of the sole 110 of the shoe 100 is not critical to the invention. The sole of a typical simple athletic shoe will typically comprise a series of layers of differing materials with differing characteristics. The shoe 100 of FIG. 1 includes a tough outsole 112, a cushioned midsole 114, and an insole 116. The sole 110 is typically affixed on its top surface to the lower margin of the upper portion
20 102 of the shoe 100 by the use of an adhesive.

A key element of the invention is the ability of the shoe 100 to monitor impacts experienced by the shoe 100, which allows an estimation of the remaining life of the shock absorbing capability of the shoe 100 based on analysis of the collected

impact data. Thus, the invention deviates from a conventional shoe design in having certain apparatus associated with the shoe 100 for performing the desired function. Referring to FIG. 1, the major components include at least one force or impact sensor 120, operational circuitry 122 to manipulate the data received from the impact sensors 120, display apparatus 124 for displaying a signal from the operational circuitry 122 either in audible or visual form, and a power source 126 to provide the necessary electric power. The invention also preferably includes a switch or button 128 for activating the display 124. FIG. 2 shows a block diagram of an embodiment of circuitry of the invention of FIG. 1.

10

Referring to FIG. 1, at least one impact sensor 120 is preferably located under either the ball of the foot or the heel, however, it is preferred that two or more impact sensors 120 be used, so that at least one impact sensor 120 is located under both the heel and the ball of the foot. The impact sensor 120 is preferably molded into the midsole 114 of the shoe 100, although in alternate embodiments the impact sensor 120 could be located elsewhere. For example, the impact sensors 120 may be located in the insole 116, or under the insole 116 but above the midsole 114, or adjacent to the outsole 112, or in any other desired location. In some alternate embodiments, it may be desirable to use an accelerometer as the impact sensor 120 located in the upper portion 102 of the shoe.

20

Impact sensors, pressure sensors, accelerometers and the like are generally well known, and many kinds of such devices may be useable in the present invention. It is preferable that the sensor 120 be inexpensive, easily customizable for different

shoe designs and configurations, and compact in size for easy incorporation into various shoe designs. Because the impact sensors 120 are preferably embedded in the sole 110 of the shoe 100 and may not be easily replaceable, it is preferable that the impact sensors 120 be rugged and resistant to mechanical fatigue. In preferred
5 embodiments of the invention the impact sensors 120 can also sense the magnitude of the force of the impact experienced by the shoe 100, and provide a signal that conveys data regarding the force of the impact.

Piezoelectric force sensors have been found to typically include the desired
10 characteristics discussed above, and LDT-0 piezo ceramic material made by Measurements Specialties Incorporated has been used successfully in prototypes. If a single sensor 120 is inadequate to provide the desired signal strength, additional sensors 120 may be used to increase the signal strength. Additional sensors 120 may also be used to improve the monitoring of the shoe wear. FIGS. 3a and 3b, show one
15 preferred embodiment of an impact sensor 120 wherein the sensor 120 comprises a laminate piezoelectric sheet element 132 with a rigid element 134 positioned above the piezoelectric sheet element 132. Referring to FIG. 3a an impact sensor 120 is shown in a neutral position with the rigid element 134 laminated onto the piezoelectric sheet element 132. In alternate embodiments, other configurations may
20 be used, or the rigid element 134 may simply comprise a local higher density foam. In the embodiment shown, the sensor 120 is positioned between the midsole 114 and the insole 116 of the sole 110 of the shoe 100. When a wearer takes a step, for example, the impact of the step will cause the foot to compress the compressible midsole 114 of the sole 110 of the shoe 100 as seen in FIG. 3b. This compression will cause a

deflection of the piezoelectric sheet element 132 of the impact sensor 120. The rigid element 134 increases the localized deflection of the piezoelectric sheet element 132. The deflection of the piezoelectric sheet element 132 generates a current proportional to the degree of deflection, and thus proportional to the force of the impact
5 experienced by the sensor 120.

Referring to FIG. 2, The impact sensors 120 are electrically coupled to the operational circuitry 122, which preferably includes some kind of microprocessor 140. The current output from an impact sensor 120 configured as set forth above is quite
10 low, possibly as low as one micro amp. The small varying levels of current output from the sensor 120 must be detected by the microprocessor 140. Conventional design techniques suggest the use of an amplifier to convert the low current to useable voltage. However, a suitable amplifier would be prohibitively expensive. The preferred solution is to use a resistor divider network 142 in conjunction with the
15 inherent characteristics of the microprocessor input pins 144 to detect varying levels of sensor 120 current output. The voltage of the system is equal to the current from the sensors 120 multiplied by the resistance of the resistor network 142, and the use of high impedance resistors in the resistor network 142 allows the generation of a useable voltage level from the low current provided by sensors 120, which also has
20 the simultaneous effect of performing an analog to digital signal conversion.

FIG. 4 shows a schematic of a preferred embodiment of the circuitry of the resistor network 142 including a series of high impedance resistors 146 configured such that a number of microprocessor input pins 144 are connected between the

resistors 146. Only a single impact sensor 120 with a three threshold level resistor network 142 is shown in FIG. 4. However, in alternate embodiments, the as little as one threshold level could be used, and any number of sensors 120 may be used, and the sensors 120 may aggregate the signals to a single resistor network 142, or the
5 sensors 120 may have separate resistor networks 142, or a combination thereof, depending on what is being accomplished with a given sensor 120. Furthermore, the threshold levels may be the same or different for different sensors 120, and the number of thresholds may be varied between sensors 120 as desired. For example, in some embodiments, it may be desirable to use only two threshold levels for the sensor
10 120 under the ball of the foot in the shoe 100, but to use three threshold levels for the sensor under the heel of the foot in the shoe 100.

The individual resistor 146 impedance values are chosen such that the logical high input condition of selected input pins 144 are met when a certain selected impact
15 threshold is reached. Thus, the impedance values of the resistors 146 are preferably not identical. The threshold values selected are preferably determined by reference to test data obtained from actual tests performed on actual shoes 100, or on the materials used in the shoes 100.

20 In the case of a three threshold system as shown in FIG. 5, a low threshold signal, for example a signal generated by a walking impact, would be sensed when the sensor 120 output current is sufficiently high to generate a voltage that meets or exceeds the logic high voltage of only one input pin 144.

A medium threshold signal, such as a signal generated by a running impact for example, would be sensed when the sensor 120 output current is sufficiently high to generate a voltage that meets or exceeds the logic high voltage of only two input pins 144.

5.

A high threshold signal, for example a signal generated by a jumping or sprinting impact, would be sensed when the sensor 120 output current resulted in a voltage that is sufficiently high to generate a voltage that meets or exceeds the logic high voltage for all three input pins 144.

10.

As previously stated, the operational circuitry 122 preferably comprises an integrated circuit device such as a microprocessor 140 formed using conventional or known integrated circuit manufacturing techniques. The operational circuitry 122 is preferably positioned at a location in the sole 110 of the shoe 100 that experiences as little flexure or stress as possible. However, in alternate embodiments the operational circuitry 122 could be positioned virtually anywhere on the shoe 100. As has been explained, it is the primary object of the invention to calculate and display an estimated remaining useful life of the shock absorbing capabilities of the shoe 100. However, in alternate embodiments, the sensors 120 and the operational circuitry 122 may also be used to sense, analyze, and display other kinds of data of interest to the user, and to perform other data analysis functions relating to the use the shoe 100.

Based on the environment in which the operational circuitry 122 must function, it is preferable that the operational circuitry 122 has low power requirements

to reduce the demand on the power source 126. It is currently preferred that the operational circuitry 122 operate on a voltage range between 1 and 9 volts, and more preferably approximately 3 volts. It is also preferable that the operational circuitry 122 be inexpensive, compact in size, and easily customizable for integration into various shoe 100 designs. Finally, it is also preferable that the operational circuitry 122 be rugged and resistant to mechanical fatigue. The operational circuitry 122 can be assembled from off the shelf or customized components. In alternate embodiments, it may be necessary or desirable to include a voltage limiting device to protect the operational circuitry from high sensor output levels.

10

In prototypes, a Microchip PIC 16C505 microprocessor, mounted on a small board including the resistor network 142, has been used successfully as the microprocessor 140 in the operational Circuitry. In alternate embodiments, much of the operational circuitry 122 may be placed in a single ASIC (Application Specific Integrated Circuit) or other custom circuitry with ease. In this embodiment, it is preferred that the ASIC or other custom circuitry have a low cost surface mount package to reduce manufacturing costs, and the resistor network 142 is preferably formed in the ASIC or other custom circuitry. The circuit board may also include a fixture to hold the power source 126. However, in alternate embodiments the power source 126 may be a separate component. The LEDs are wired to the circuit board and are in electrical communication with the power source 126 and the operational circuitry 122 which controls the lighting of the LEDs 152 in response to a wear status request, i.e. activation of the display by depressing button 128. Many modifications to the circuit may be easily made by those skilled in the art.

The power source 126 is preferably mounted on the board of the operational circuitry 122, and is in electrical communication with the operational circuitry 122. A three volt lithium coin cell was used successfully in prototypes. However, many known battery types may be useable or preferred. The preferred battery will be small, inexpensive, and will last for the life of the shoe 100. In alternate embodiments other power sources 126 may be used, including solar panels or fuel cells. In still other embodiments, the power source 126 may be replaceable or rechargeable. In further embodiments, the invention may be powered by the current generated by the sensors, or by other piezoelectric elements. In embodiments using a rechargeable battery, the battery may be charged by the sensors or other piezoelectric elements associated with the shoe, or the battery may be recharged inductively or by a solar panel or other recharge source.

The invention also comprises a display apparatus 124 for displaying a signal from the operational circuitry 122 either in a form that may be perceived by the user, including audible, visual, or tactile form. The wires to the display 124 may be molded into the shoe 100 and may be routed by any acceptable path through the sole 110 of the shoe 100. The display 124 may be located at any convenient location on the shoe 100 or on the upper 102 of the shoe 100, but is preferably located at the heel 108 of the upper 102 of the shoe 100 as seen in FIGS 6 and 7. The location of display 124 selected will depend both on functional and ornamental factors in the design of the shoe 100.

The preferred display 124 is inexpensive, rugged, waterproof, dust proof, impact resistant, compact in size, easily customizable for different shoe designs, and uses little power. Although it is possible to design the shoe 100 such that the display 124 merely displays when the shoe 100 should be replaced, it is anticipated that consumers would prefer to have some warning of the expiration of the shoe 100. Accordingly, it is preferable that the display 124 shows the estimated remaining life of the shoe 100 on a relative scale. For visual displays 124, it is preferable that the display 124 is visible in lighting conditions including low light, ambient indoor lighting, and direct sunlight. Audible displays should be readily audible in various environments, yet not so loud as to embarrass or irritate the user.

Prototypes have been constructed using five LEDs 152 embedded in resin, and given a matte finish to increase the effective viewing angle of the LEDs 152, as seen in FIG. 5. The LEDs 152 may be mounted directly on the shoe 100, or may be mounted under a translucent diffusion panel or cover, such as a molded clear plastic to which a frosted surface has been applied. Such diffusion panels or other suitable apparatus may be used to increase the angles from which the LED 152 light is visible.

Many other modifications of the display 124 are possible within the scope of the invention. For example, the number and colors of the LED's may be varied, or, with appropriate substitution of circuitry, other displays 124 may be used, including but not limited to, as electroluminescent displays, liquid crystal displays, flexible liquid crystal displays, or heat activated displays, may be used for display 124. If such panels are used for display 124, the display 124 may provide alpha numeric

information as seen in FIG 6. The use of panels also allows the use of graphics, images, or pictograms rather than alpha numeric symbols on the display 124. If an audible display 124 is desired, a piezo ceramic element may be used to generate the audible signal.

5

In order to reduce power consumption, it is preferable that the status of the shoe 100 be displayed only upon user request. Thus, it is preferable that a switch or button 128 be incorporated in the shoe 100 for activating the display 124. A large number of such buttons or switches are known. The preferred button 128 will be
10 small, inexpensive, easily customizable for different shoe designs, waterproof, dust proof, impact resistant, and will provide tactile feedback when activated. In prototypes, a snap dome switch mounted to a flex circuit has been found acceptable for use.

15 In use, the user wears the shoe 100 like any other shoe 100. No on/off switch is necessary, as the electronics are preferably activated by the receipt of signals from the impact sensors 120. The impact sensors 120 respond to the various impacts experienced by the shoe 100 and send an electrical signal with a signal magnitude that varies depending on the force of the impact strength to the resistor network 142. The
20 resistor network 142 allows the differentiation of the signal by signal strength and converts the analog signal received from the sensors 120 to a signal intended to be detected by digital circuitry, as previously described, and sends the signal to the microprocessor 140. The microprocessor 140 applies pre-programmed algorithms to generate a numerical value. The algorithms applied are preferably based on data

derived from tests on shoes similar to the shoe 100, or on tests on the materials used in the sole 110 of the shoe 100. This value is added to a sum of such values. The accumulated sum of values represents an estimate of the amount of, or accumulation of, wear on the shoe 100. When the display 124 button is depressed, the current sum
5 of values is compared against a pre-determined threshold value. If the threshold has been exceeded, the display 124 will indicate visually or audibly that the shoe 100 must be replaced. In preferred embodiments if the sum is less than the threshold value, the display 124 will indicate an approximate percentage of the life of the shoe 100 remaining.

10

In alternate embodiments the microprocessor 140 may separately sum the wear in different parts of the sole 110 of the shoe 100. For example, it may be desirable to separately track the accumulation of wear on the heel portion of the sole 110 of the shoe 100 and on the portion of the sole 110 of the shoe 100 under the ball of the foot,
15 so that if the shock absorbing ability of one portion of the sole 110 expires before the other, the user may be informed that the shoe should be replaced.

(a) providing a pre-determined numerical value; (b) receiving a signal from an impact sensor; (c) applying an algorithm to derive a value; (d) adding the numerical
20 value of step (c) to a sum of such values to create a new value; (e) comparing the new value of step (d) to the pre-determined value of step (a); (f) estimating the remaining life of the shock absorbing ability of the shoe based on the results of the comparison in step (e).

The method of the invention may also comprise the step of (g) displaying the remaining life of the shock absorbing capability of the shoe based on the results of the comparison in step (f). In another embodiment, the signal from the sensor may be conditioned before step (b), preferably by using a resistor divider network. Also, the
5 method of the invention may be performed separately for separate sensors.

To those skilled in the art, many changes and modifications will be readily apparent from consideration of the foregoing description of a preferred embodiment without departure from the spirit of the present invention; the scope thereof being
10 more particularly pointed out by the following claims. The description herein and the disclosures hereof are by way of illustration only and should not be construed as limiting the scope of the present invention which is more particularly pointed out by the following claims. For example, the invention has been disclosed in the context of an athletic shoe, however, the invention may be incorporated in to many other kinds of
15 shoes or other footwear.

CLAIMS

What is claimed is:

- 1 1. A shoe including a sole having a shock absorbing capability, and a life span of
2 the shock absorbing capability, comprising:
3
4 at least one sensor responsive to impacts experienced by the shoe, and capable of
5 producing an electric current.
6
7 operational circuitry in communication with the sensor, the operational circuitry
8 capable of manipulating data received from the sensor to estimate a remaining life of
9 the shock absorbing capabilities of the shoe,
10
11 a display apparatus in communication with the operational circuitry.
- 1 2. The shoe of claim 1, wherein the sensor is also used as a power source.
- 1 3. The shoe of claim 1, further comprising a power source.
- 1 4. A shoe including a sole having a shock absorbing capability, and a life span of
2 the shock absorbing capability, comprising:
3
4 at least one sensor responsive to impacts experienced by the shoe,

5
6 a resistor network in communication with the sensor,
7
8 a microprocessor in communication with the resistor network, the microprocessor
9 capable of manipulating the signal received from the sensor through the resistor
10 network to estimate a remaining life of the shock absorbing capabilities of the shoe,
11
12 a power source, and
13
14 a display apparatus in communication with the microprocessor.

1 5. The shoe of claim 4 wherein the sensor sends a signal through the resistor
2 network to the operational circuitry, and a strength of the signal varies depending on
3 the force of an impact experienced by the sensor.

1 6. The shoe of claim 4, wherein the sensor comprises a piezoelectric element.

1 7. The shoe of claim 4, wherein shoe comprises at least two sensors.

1 8. The shoe of claim 7 wherein at least one sensor is located proximate a heel
2 portion of the sole of the shoe, and at least one sensor is located proximate a toe
3 portion of sole of the shoe.

- 1 9. The shoe of claim 6, wherein the sensor further comprises a rigid body
2 positioned proximate the piezoelectric element to enhance the deformation of the
3 piezo element.
- 1 10. The shoe of claim 4, wherein the resistor network converts the signal to a
2 useable voltage and converts the signal to a form sensed by digital circuitry.
- 1 11. The shoe of claim 10, wherein the resistor network sends signals to the
2 operational circuitry that vary depending on the strength of the signal received from
3 the sensor.
- 1 12. The shoe of claim 4, wherein the display is a visual display.
- 1 13. The shoe of claim 4, wherein the display is an audible display.
- 1 14. The shoe of claim 4 wherein the display is a tactile display.
- 1 15. The shoe of claim 4, wherein the display is selected for the group consisting
2 of: light emitting diodes, electroluminescent displays, liquid crystal displays, flexible
3 liquid crystal displays, or heat activated displays.
- 1 16. The shoe of claim 4, wherein the display is in alphanumeric form.
- 1 17. The shoe of claim 4, wherein the display comprises one or more graphics.

1 18. The shoe of claim 4, further comprising a button to activate the display.

1 19. The shoe of claim 4 wherein the power source is a piezoelectric element.

1 20. The shoe of claim 4 wherein the power source is the sensor.

1 21. The shoe of claim 14, wherein the audible display comprises a piezoelectric
2 speaker element.

1 22. A method for estimating the approximate useful remaining life of the shock
2 absorbing capability of the shoe, wherein the shoe comprises at least one sensor,
3 operational circuitry in communication with the sensor, wherein the operational
4 circuitry is capable of manipulating data received from the sensor to estimate the
5 remaining life of the shock absorbing capabilities of the shoe, a power source
6 electrically coupled to the operational circuitry, and a display in communication with
7 the operational circuitry capable of displaying information related to the remaining
8 useful life of the shock absorbing capabilities of the shoe; the method comprising the
9 following steps:

10

11 (a) Providing a pre-determined numerical value

12

13 (b) Receiving a signal from a force sensor

14

- 15 (c) Applying an algorithm to the force signal to derive a value
16
- 17 (d) Adding the numerical value of step (c) to a sum of such values to create a new
18 value.
19
- 20 (e) Comparing the new value of step (d) to the pre-determined value of step (b).
21
- 22 (f) estimating the remaining life of the shock absorbing ability of the shoe based
23 on the results of the comparison in step (e).

1 23. The method of claim 22, further comprising the step of (g) displaying the
2 remaining life of the shock absorbing ability of the shoe based on the results of the
3 comparison in step (f).

1 24. The method of claim 22, wherein steps (a) through (f) are performed separately
2 for separate sensors.

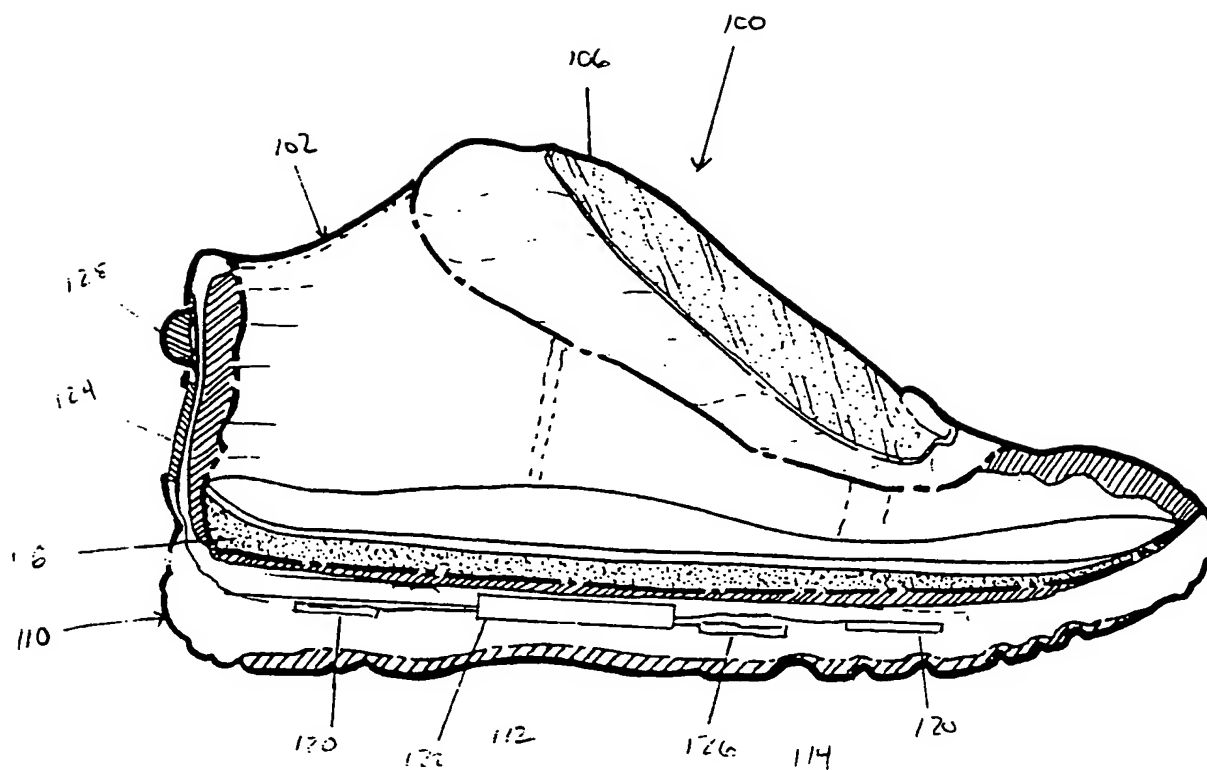
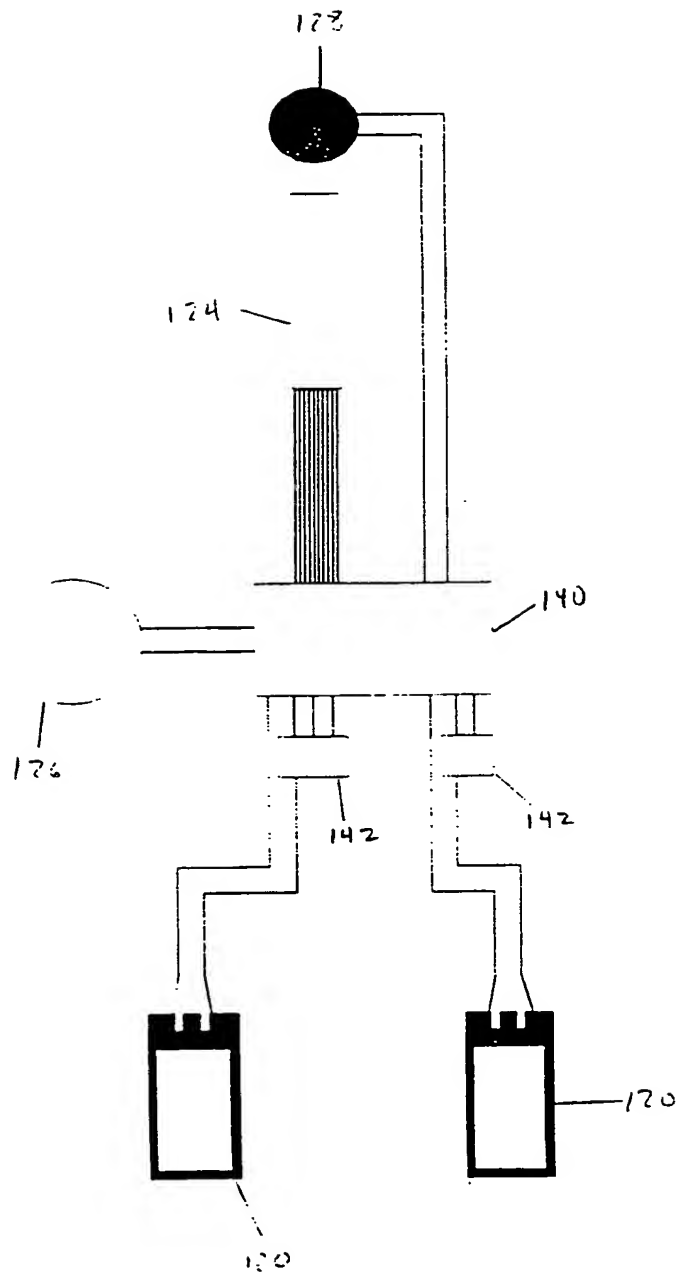
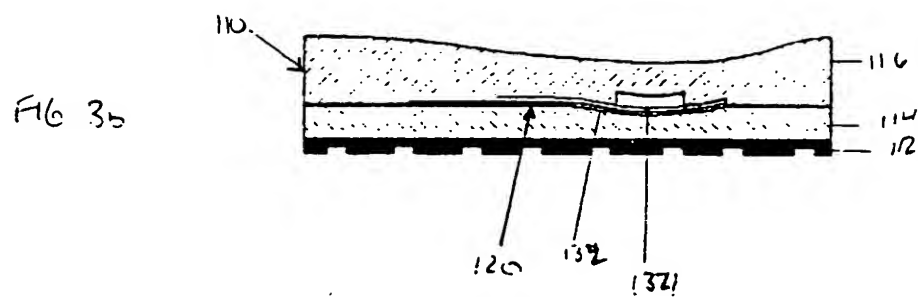
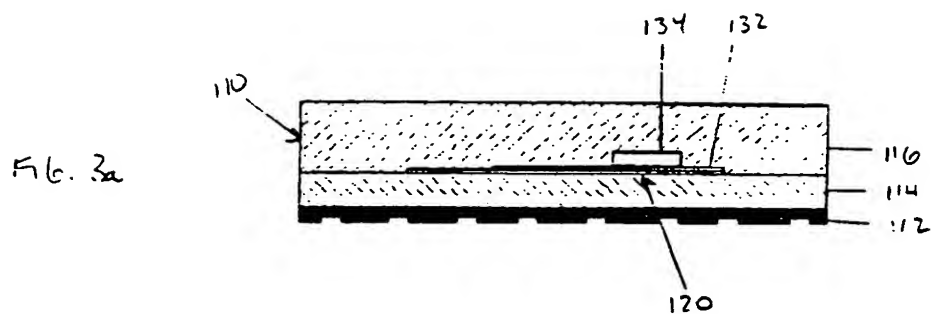
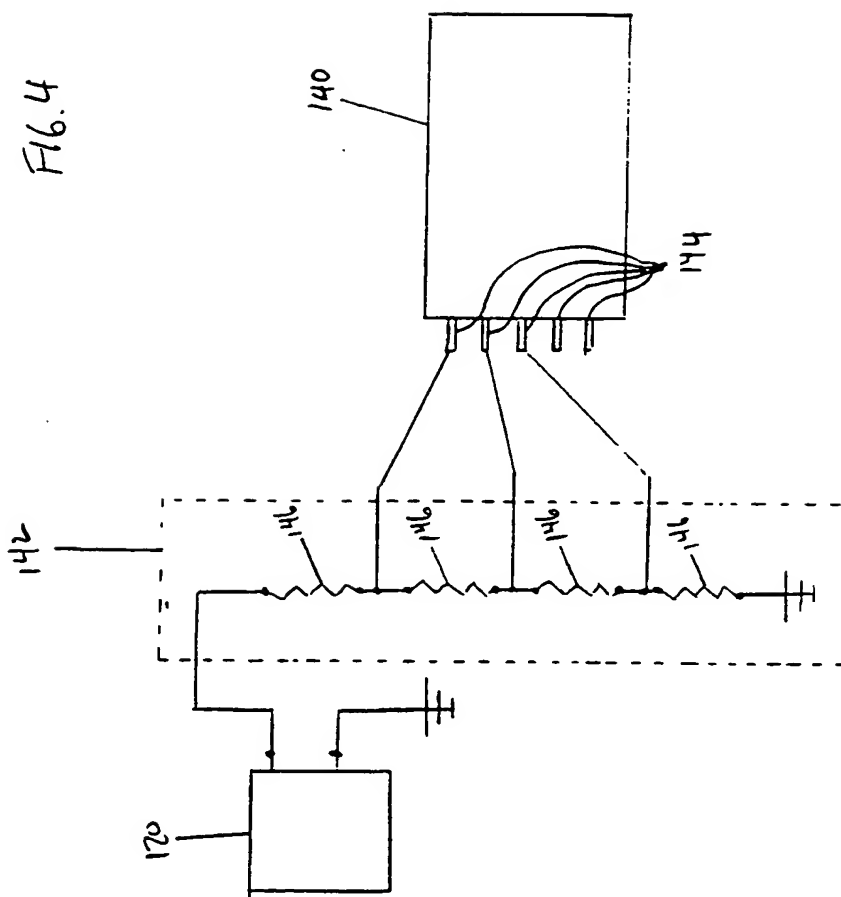
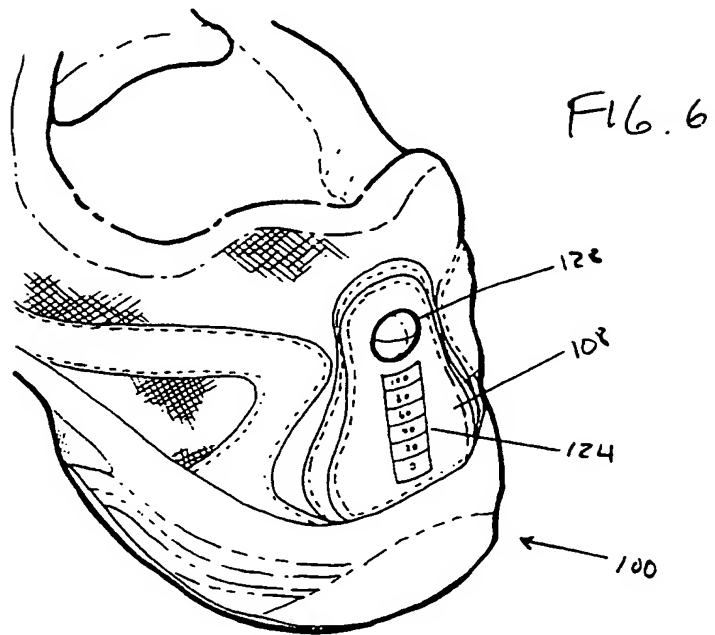
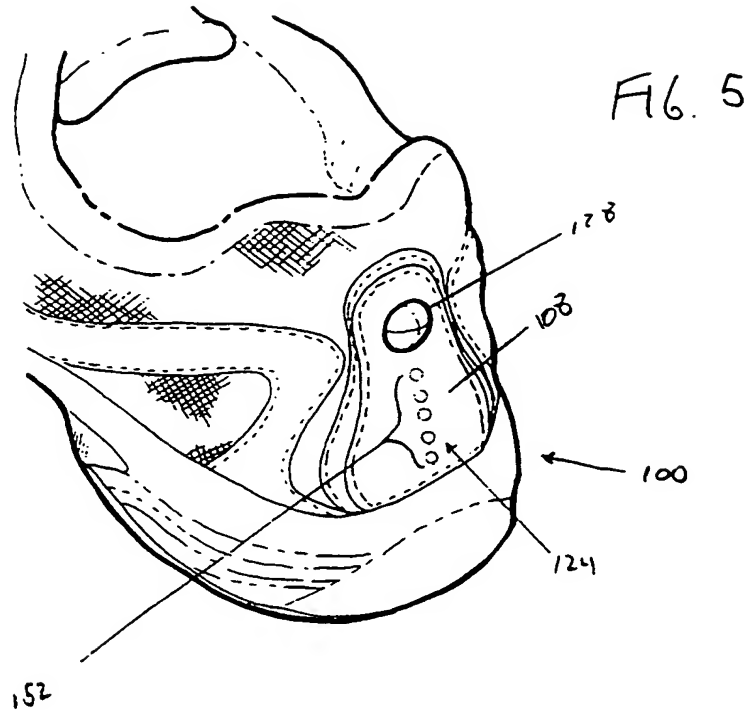


Fig. 1









INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 00/40244

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 A43B3/00 A43B5/00 A43B13/22

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 A43B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EP0-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
----------	--	-----------------------

X	US 5 471 405 A (MARSH STEPHEN A) 28 November 1995 (1995-11-28) column 2, line 64 -column 3, line 2 column 3, line 66 -column 5, line 37; figures 1-3 column 8, line 53 -column 9, line 7	1,3,22, 23
Y		2,4-8, 10-12, 15,16, 18-20
A	---	9,13,14, 17
	-/--	

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

8 November 2000

Date of mailing of the international search report

15/11/2000

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Chapple, I

INTERNATIONAL SEARCH REPORT

International Application No.

PCT/US 00/40244

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 0 901 012 A (FIGARO ENG) 10 March 1999 (1999-03-10) column 9, line 19 -column 10, line 22; figure 1 ---	4-8, 10-12, 15,16, 18-20
Y	US 4 748 366 A (TAYLOR GEORGE W) 31 May 1988 (1988-05-31) column 5, line 56 -column 6, line 3; figure 5 ---	2,19,20
Y	US 5 500 635 A (MOTT JONATHAN C) 19 March 1996 (1996-03-19) column 17, line 8 - line 21; figure 7 -----	6
A		7,8

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US 00/40244

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 5471405	A	28-11-1995	NONE	
EP 0901012	A	10-03-1999	CN 1213082 A JP 11148908 A US 6055849 A	07-04-1999 02-06-1999 02-05-2000
US 4748366	A	31-05-1988	NONE	
US 5500635	A	19-03-1996	AT 123563 T AU 7340191 A CA 2073691 A DE 69110277 D DE 69110277 T EP 0516703 A WO 9113288 A JP 5504283 T AU 1956492 A CA 2073586 A EP 0522882 A JP 5228002 A KR 9611268 B	15-06-1995 18-09-1991 21-08-1991 13-07-1995 19-10-1995 09-12-1992 05-09-1991 08-07-1993 14-01-1993 13-01-1993 13-01-1993 07-09-1993 21-08-1996

PATENT COOPERATION TREATY

PCT

REC'D 29 JAN 2002

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

WIPO

PCT

(PCT Article 36 and Rule 70)

101018897

Applicant's or agent's file reference 192-001	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/US00/40244	International filing date (day/month/year) 19 JUNE 2000	Priority date (day/month/year) 18 JUNE 1999
International Patent Classification (IPC) or national classification and IPC IPC(7): A43B 23/00 and US Cl.: 36/136		
Applicant MYERS, STEVE		

<p>1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of <u>3</u> sheets.</p> <p><input type="checkbox"/> This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority. (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).</p> <p>These annexes consist of a total of <u>0</u> sheets.</p>		<p>RECEIVED MAR 21 2002 AUG 26 2002 TC 3700 MAIL ROOM TECHNOLOGY CENTER 3700</p>
<p>3. This report contains indications relating to the following items:</p> <p>I <input checked="" type="checkbox"/> Basis of the report</p> <p>II <input type="checkbox"/> Priority</p> <p>III <input type="checkbox"/> Non-establishment of report with regard to novelty, inventive step or industrial applicability</p> <p>IV <input type="checkbox"/> Lack of unity of invention</p> <p>V <input checked="" type="checkbox"/> Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement</p> <p>VI <input type="checkbox"/> Certain documents cited</p> <p>VII <input type="checkbox"/> Certain defects in the international application</p> <p>VIII <input type="checkbox"/> Certain observations on the international application</p>		

Date of submission of the demand 17 JANUARY 2001	Date of completion of this report 18 DECEMBER 2001
Name and mailing address of the IPEA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231	Authorized officer PAUL SEWELL
Facsimile No. (703) 305-3230	Telephone No. (703) 308-2126

I. Basis of the report**1. With regard to the elements of the international application:***

- ☒ the international application as originally filed
- ☒ the description
pages: 1-20 , as originally filed
pages: NONE , filed with the demand
pages: NONE , filed with the letter of
- ☒ the claims:
pages: 21-25 , as originally filed
pages: NONE , as amended (together with any statement) under Article 19
pages: NONE , filed with the demand
pages: NONE , filed with the letter of
- ☒ the drawings:
pages: 1-5 , as originally filed
pages: NONE , filed with the demand
pages: NONE , filed with the letter of
- ☒ the sequence listing part of the
description: NONE , as originally filed
pages: NONE , filed with the demand
pages: NONE , filed with the letter of

2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language which is:

- ☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international

- ☐ contained in the international application in printed form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☒ The amendments have resulted in the cancellation of:

- ☒ the description, pages: NONE
- ☒ the claims, Nos. NONE
- ☒ the drawings, sheets: NONE

- ☐ This report has been drawn as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

**Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/US00/40244

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**1. statement**

Novelty (N)	Claims	<u>2, 4-24</u>	YES
	Claims	<u>1, 3</u>	NO
Inventive Step (IS)	Claims	<u>14, 21, 24</u>	YES
	Claims	<u>1-13, 15-20, 22, 23</u>	NO
Industrial Applicability (IA)	Claims	<u>1-24</u>	YES
	Claims	<u>NONE</u>	NO

2. citations and explanations (Rule 70.7)

Claims 1 and 3 lack novelty under PCT Article 33(2) as being anticipated by Marsh. Regarding claim 1, Marsh teaches a shoe with a sole and shock absorbing capability comprising a sensor 14L, operational circuitry 32L and a display apparatus 20. Regarding claim 3, Marsh teaches a power source.

Claims 2, 4-13, 15-20, 22 and 23 lack an inventive step under PCT Article 33(3) as being obvious over Marsh in view of Mott. Regarding claim 2, Mott teaches using the piezoelectric sensor as a power source. It would have been obvious to use the sensor of Marsh as power source in order to reduce the number of components. Marsh teaches all the limitations of claim 4 except a resistor network in communication with the sensor. Mott teaches a resistor network. It would have been obvious to one of skill in the art to incorporate the resistor network into the invention of Marsh in order to make the circuit more durable. Claims 5-13 are either clearly taught by Marsh or are obvious modifications in view of Mott, who teaches an analogous system. Marsh teaches claims 15-18; Mott teaches claim 19 and 20. It would have been obvious to modify Marsh regarding these claims as noted above.

Claims 22 and 23 are directed to obvious methods of using the invention of Marsh. Claim 24 also appears to be an obvious method of using the invention of Marsh.

____ NEW CITATIONS _____
NONE

PATENT COOPERATION TREATY

PCT

REC'D 29 JAN 2002

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

WIPO

PCT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 192-001	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/US00/40244	International filing date (day/month/year) 19 JUNE 2000	Priority date (day/month/year) 18 JUNE 1999
International Patent Classification (IPC) or national classification and IPC IPC(7): A43B 23/00 and US Cl.: 36/136		
Applicant MYERS, STEVE		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 5 sheets.

☐ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority. (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 0 sheets.

3. This report contains indications relating to the following items:

I ☒ Basis of the report

II ☐ Priority

III ☐ Non-establishment of report with regard to novelty, inventive step or industrial applicability

IV ☐ Lack of unity of invention

V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

VI ☐ Certain documents cited

VII ☐ Certain defects in the international application

VIII ☐ Certain observations on the international application

Date of submission of the demand 17 JANUARY 2001	Date of completion of this report 18 DECEMBER 2001
Name and mailing address of the IPEA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231	Authorized officer PAUL SEWELL
Facsimile No. (703) 305-3230	Telephone No. (703) 308-2126

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/US00/40244

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pages: 1-20 , as originally filed
pages: NONE , filed with the demand
pages: NONE , filed with the letter of _____
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pages: NONE , filed with the letter of _____
- ☒ the drawings:
pages: 1-5 , as originally filed
pages: NONE , filed with the demand
pages: NONE , filed with the letter of _____
- ☒ the sequence listing part of the
description: NONE , as originally filed
pages: NONE , filed with the demand
pages: NONE , filed with the letter of _____

2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

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- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☒ The amendments have resulted in the cancellation of:

- ☒ the description, pages: NONE
- ☒ the claims, Nos.: NONE
- ☒ the drawings, sheets: 4-6 NONE

☐ This report has been drawn as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.3(c)).

* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

**Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/US00/40244

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	Claims <u>1, 3</u>	NO
Inventive Step (IS)	Claims <u>14, 21, 24</u>	YES
	Claims <u>1-13, 15-20, 22, 23</u>	NO
Industrial Applicability (IA)	Claims <u>1-24</u>	YES
	Claims <u>NONE</u>	NO

2. citations and explanations (Rule 70.7)

Claims 1 and 3 lack novelty under PCT Article 33(2) as being anticipated by Marsh. Regarding claim 1, Marsh teaches a shoe with a sole and shock absorbing capability comprising a sensor 14L, operational circuitry 32L and a display apparatus 20. Regarding claim 3, Marsh teaches a power source.

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____ NEW CITATIONS _____
NONE